

**Report
Geotechnical Engineering Services
Preliminary Coal Mine Hazard Assessment
King County Parcel Nos. 332406-9029,
-9036, -9039,-9045 and -9066
Issaquah, Washington**

**July 7, 2015
ICE File No. 1131-001**

**Prepared For:
Boardwalk Real Estate LLC**

**Prepared By:
Icicle Creek Engineers, Inc.**

ICICLE CREEK ENGINEERS

Geotechnical, Geologic and Environmental Services

July 7, 2015

Ken Lyons
Boardwalk Real Estate LLC
17533 - 47th Avenue NE
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Report
Geotechnical Engineering Services
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1.0 INTRODUCTION

This report summarizes Icicle Creek Engineers' (ICE's) preliminary coal mine hazard assessment for five parcels (King County Parcel Nos. 332406-9029, -9036, -9039, -9045 and -9066) located in Issaquah, Washington. We understand that plans are being considered for residential development of these parcels. The subject parcels are shown relative to nearby physical features on the Vicinity Map, Figure 1. The specific parcels are shown on the Site Plan, Figure 2.

Our services were completed in general accordance with our Confirming Agreement dated February 20, 2015 and were authorized in writing by Kenneth W. Lyons on July 6, 2015.

According to the City of Issaquah Critical Areas mapping, the lots are located in a "Coal Mine Hazard Area." Because the property is in a Coal Mine Hazard Area, a preliminary coal mine hazard assessment is required as a means to evaluate the location of Coal Mine Hazards (Severe, Moderate or Declassified).

2.0 SCOPE OF SERVICES

The purpose of our services was to complete a preliminary assessment of the potential hazards associated with past underground coal mining in the subject parcel area. Specifically, our services included the following:

- Review available historic coal mine records from the City of Issaquah, Washington State Department of Natural Resources and our in-house technical library to evaluate the location of the mined-out areas, together with the depth of mining, thickness of zone mined and mining methods.
- Mine mapping included superimposing the identified mines onto a parcel area base map obtained from King County iMAP. The map was then used to develop two geologic cross-sections showing the interpreted location and depth of mined-out areas.
- Surface reconnaissance mapping of the lots to identify mine openings such as adits or air shafts, together with stockpiles of mine rock fill or other areas in which the original ground surface has been altered.
- Classify the mine hazards as Severe Coal Mine Hazard Areas, Moderate Coal Mine Hazard Areas or Declassified Coal Mine Areas.

- Develop preliminary mitigation for building design and construction related to the Coal Mine Hazards.
- Provide recommendations for additional study based on the results of this preliminary coal mine hazard assessment.

3.0 CITY OF ISSAQUAH COAL MINE HAZARD REGULATION

The City of Issaquah has established guidelines for evaluation of coal mine hazards generally based on King County Administrative Guidelines (AG) dated March 1999 and King County Ordinance 13319 dated November 9, 1998 (John Minato, City of Issaquah Building Department, personal communication, October 31, 2000).

According to Issaquah Municipal Code Chapter 18.10.520, "Alteration of a site containing a coal mine hazard area may be permitted only when all significant risks associated with abandoned mine workings have been eliminated or mitigated. Appropriate mitigation shall be based upon a critical areas study that has been prepared by a qualified professional."

The primary issues regarding public health and safety and/or property damage related to abandoned underground coal mines as defined by the King County AG include:

- **Severe Coal Mine Hazard Areas** - Severe Coal Mine Hazard Areas are *"those areas that pose significant risks of catastrophic ground surface collapse. Severe coal mine hazard areas may typically include, but are not limited to, areas characterized by unmitigated openings such as entries, portals, adits, mine shafts, air shafts, timber shafts, sinkholes, improperly filled sinkholes, and other areas of past or significant probability for catastrophic ground surface collapse. Severe coal mine hazard areas typically include, but are not limited to, overland surfaces underlain or directly affected by abandoned coal mine workings from a depth of zero to one hundred fifty feet."*
- **Moderate Coal Mine Hazard Areas** - Moderate Coal Mine Hazard Areas are *"those areas that pose significant risks of property damage which can be mitigated by special engineering or architectural recommendations. Moderate coal mine hazard areas may typically include, but are not limited to, areas underlain or directly affected by abandoned coal mine workings from a depth of zero to three hundred feet or with overburden-cover-to-seam thickness ratios of less than ten to one dependent on the inclination of the seam."*
- **Declassified Coal Mine Areas** - Declassified Coal Mine Areas are *"those areas for which a risk of catastrophic collapse is not significant and which the hazard assessment report has determined require no special engineering or architectural recommendations to prevent significant risks of property damage. Declassified coal mine areas may typically include, but are not limited to, areas underlain or directly affected by coal mines at depths greater than three hundred feet as measured from the surface but may often include areas underlain or directly affected by coal mines at depths less than three hundred feet."*

Other considerations include the possible presence of mine rock fill and undocumented mining. Mine rock fill includes stockpiles of mining by-products consisting of broken rock and coal. Undocumented mining, typically as shallow prospects, have been encountered in the vicinity of large-scale documented coal mining.

4.0 ABANDONED UNDERGROUND COAL MINE DESCRIPTION

4.1 GENERAL

Past underground coal mining in the project area was evaluated by reviewing the following documents:

- Goodson & Associates, October 28, 1984, *Abandoned Coal Mine Survey of Issaquah, King County, Washington*, prepared for the Office of Surface Mining (OSM), Denver, Colorado.
- Schasse, H.W., Koler, L.M., Eberle, N.A. and Christie, R.A., May 1994, *The Washington State Coal Mine Collection Guide: A Catalog, Index and User's Guide - Pacific Coast Coal Company, Upper and Lower Bagley Seams*, (<https://fortress.wa.gov/dnr/geology/?Theme=coalmine>), Map K7.
- King County iMAP, <http://gismaps.kingcounty.gov/iMap/>, aerial photograph dated 1936.

4.2 ABANDONED UNDERGROUND COAL MINES

The abandoned coal mines that underlie the subject parcels are referred to as the "Issaquah Mines." The Issaquah Mines were active from the late 1800s up until the 1940s. At least five underground mines were developed on coal seams dipping down to the north at a 35 to 40 degree angle extending from Issaquah to Newcastle. In the Issaquah area, the main entries to these mines were located along the base of Squak Mountain (lower Wildwood Boulevard/Mine Hill Road area).

Within the study area for this report, the abandoned No. 4 Mine underlies all five parcels, and the abandoned No. 1 Mine underlies the southeast corner of the southernmost parcel (Parcel No. 332406-9045) as shown on the Abandoned Underground Coal Mine Map, Figure 3 and Geologic Cross-Sections A-A' and B-B', Figures 4 and 5, respectively. Based on our review and evaluation, abandoned underground coal mine(s) underlie the parcels (from south to north) at an approximate depth as follows.

Parcel No.	No. 1 Mine Depth (feet bgs)	No. 4 Mine Depth (feet bgs)
332406-9045	320 to 390	<25 to 180
332406-9029	-	80 to 220
332406-9066	-	220 to 250
332406-9036	-	160 to 320
332406-9039	-	230 to 395

bgs = below ground surface

The No. 4 Mine and No. 1 Mine are the oldest mine workings in the Issaquah Mines area and were abandoned in the early 1900s. Both mines were worked from Main Entries that were opened as a pair of reinforced tunnels (one for air circulation) driven down the dip of the coal seam. From this tunnel, usually referred to as the Main Slope, the coal seam was worked horizontally to the east and west to three levels referred to as the Water Level (No. 1 Mine), and the 400, 800 and 1200 Levels (No. 4 Mine). The lowest parts of these mines extended to a depth of over 200 feet below sea level.

The locations of the Main Entries to these mines are known from the historical mine maps. Currently, these Main Entry areas are covered with little evidence of the presence of this historical feature. Goodson & Associates (Goodson, 1984), under contract with the US Department of the Interior Office of Surface Mining (OSM), completed a ground subsidence (sinkhole) inventory in the early 1980s.

Based on our review of the 1984 Goodson study, the nearest reported surface subsidence feature is related to shallow workings and the Mine Entries (there were three) to the No. 4 Mine in the northeast

corner of Parcel No. 332406-9045 as shown on Figure 3 (referred to as "WAO 120" in the 1984 Goodson study). WAO 120 is described as "a main slope portal, two slope air chutes and an adit portal to the No. 4 seam workings." At the time of the 1984 Goodson study, the subsidence area was described as covered, though a large depression was observed.

5.0 SITE DESCRIPTION

5.1 GEOLOGIC SETTING

The surficial geology in the project area has been mapped by the US Geological Survey (USGS, Booth, Walsh, Troost, and Shimel "Geologic Map of the Issaquah 7.5' Quadrangle, King County, Washington," 2006, in review, Miscellaneous Field Studies, scale 1:24,000) as Renton formation bedrock. Renton formation bedrock consists of non-marine sandstone and shale with coal seams. The Renton formation bedding dips at roughly 35 to 40 degrees downward to the north beneath the subject parcels.

5.2 SURFACE CONDITIONS

Our surface reconnaissance of the subject parcels was completed on June 18, 2015 by Jeff Schwartz of ICE. The total area of the five parcels occupies about 9.95 acres and is located on an overall northeast-to east-facing hillside near the base of Squak Mountain overlooking the City of Issaquah and the Issaquah Creek valley. The subject parcels are bordered by Mine Hill Road SW to the east, and more densely developed residential properties to the north, west and south.

The subject parcels are crossed diagonally from north to south by an unnamed stream which occupies a well-defined ravine through the parcels. Overall, the ground surface slopes moderately at about a 20 to 30 percent grade west of the stream, and gently down (less than 10 percent grade) to the west side of the stream. Topographic relief varies from about Elevation 280 feet in the southwest corner to about Elevation 170 feet along the east parcel line.

Houses that were constructed in the early 1900s currently exist in the east part of each of the parcels with the exception of Parcel No. 332406-9066. The west part of each parcel (generally east of the stream) is forested and undeveloped.

Except for the stream, no surface water was observed on the subject parcels at the time of our reconnaissance.

We did not observe any topographic depressions on the subject parcels or other ground surface irregularities that may be associated with past mining activities. However, the area of WAO 120 is currently a pasture area and exhibits a subtle depression consistent with the description in the 1984 Goodson study.

6.0 ANALYSIS OF COAL MINE HAZARDS

6.1 SEVERE COAL MINE HAZARD AREAS

Severe Coal Mine Hazard Areas are underlain by abandoned underground coal mines at a depth of less than 150 feet. In these areas, there is a risk of sinkholes that could form at the ground surface.

Based on our site observations and historical mine records review, the No. 4 Mine underlies parts of Parcel Nos. 332406-9029 and -9045 at depths of less than 150 feet as shown on Figure 3 and is therefore within a Severe Coal Mine Hazard Area as shown on the Coal Mine Hazard Areas Map, Figure 6.

6.2 MODERATE COAL MINE HAZARD AREAS

Moderate Coal Mine Hazard Areas are underlain by abandoned underground coal mines at a depth of more than 150 feet and are within an area potentially affected by regional ground subsidence. Regional ground subsidence occurs when the ground surface subsides over a large area. Surface deflection is caused by plastic deformation of the strata overlying the mine as the roof sags into the mine. The affected area is expected to be much larger than the vertical projection of the underground mine workings. The effects of regional ground subsidence include vertical ground subsidence (settlement), ground tilt and ground strain.

Moderate Coal Mine Hazard Areas occur where 1) ground tilt is in excess of 1:350, that is, 1 foot of vertical settlement in 350 horizontal feet, and/or 2) ground strain is in excess of 0.003 inches per inch. Based on our analysis, total potential regional ground subsidence is estimated to be about 27½ inches. Maximum ground tilt and strain across the central part of the subject parcel area are more than the defined thresholds for structural damage and is considered a Moderate Coal Mine Hazard Area as shown on Figure 6.

6.3 DECLASSIFIED COAL MINE AREAS

At this time, the areas south of the Severe Coal Mine Hazard Area (southeast corner of Parcel No. 332406-9045) and north of the Moderate Coal Mine Hazard Areas should be considered a Declassified Coal Mine Area as shown on Figure 6.

6.4 MINE ROCK FILL

Based on our site reconnaissance, though limited by vegetation cover, we did not observe Mine Rock Fill on the surface of the subject parcels.

6.5 UNDOCUMENTED MINING

Based on our review of the historic mine maps and familiarity with this area, the risk of undocumented mining within or underlying the subject parcels is low.

7.0 CONCLUSIONS

Based on the results of this preliminary coal mine hazard assessment, the following is a list of conclusions and recommendations regarding coal mine hazards at the subject parcels:

- The abandoned No. 4 Mine underlies all five parcels, and the No. 1 Mine underlies the southeast corner of the southernmost parcel (Parcel No. 332406-9045) as shown on Figures 3, 4 and 5.
- Based on our site observations and historical mine records review, the No. 4 Mine underlies parts of Parcel Nos. 332406-9029 and -9045 as shown on Figure 3 and is therefore within a Severe Coal Mine Hazard Area as shown on the Coal Mine Hazard Areas Map, Figure 6.
- The area crossing the central part of the subject parcels should be considered a Moderate Coal Mine Hazard Area as shown on Figure 6.
- The areas south of the Severe Coal Mine Hazard Area (southeast corner of Parcel No. 332406-9045) and north of the Moderate Coal Mine Hazard Area should be considered a Declassified Coal Mine Area as shown on Figure 6.
- No topographic depressions on the property or other ground surface irregularities that may be associated with past mining activities were observed within the subject parcels with the exception of the area of WAO 120 (No. 4 Mine Entry area). This area is currently a pasture and exhibits a subtle depression consistent with the description in the 1984 Goodson study.

- Mine Rock Fill was not observed on the property; ICE should be contacted if evidence of Mine Rock Fill is encountered during earthwork activities.
- Undocumented mining is unlikely to have occurred within the subject parcels based on our field reconnaissance and information review.

8.0 RECOMMENDATIONS

8.1 SEVERE COAL MINE HAZARD AREA

No residential development should occur within the Severe Coal Mine Hazard Area. Passive use should be allowed such as pasture or lawn/landscaped areas.

8.2 MODERATE COAL MINE HAZARD AREA

Residential use within the Moderate Coal Mine Hazard Area should be allowed provided that the following mitigations for design and construction are implemented.

- Use of rigid foundations (conventional reinforced concrete spread footings) supporting a flexible superstructure (wood-frame).
- Small, square or nearly square-shaped building pads should be favored over large, irregularly-shaped building pads.
- Crawl-space construction rather than slab-on-grade. However, slab-on-grade may be used in garage and driveway areas.
- Buildings should be constructed such that they could be easily releveled.
- No brick or basement construction.
- Edges of foundations should be backfilled with loose soil or other compressible material to allow for potential ground compression.
- Underground utilities should be designed with flexible and/or telescopic couplings or fittings.
- Utilities that depend on gravity for flow (sewers and storm drain) should be designed to compensate for the potential for ground subsidence.

9.0 GROUND PROOFING

No coal mine hazards exist if the underground mines have substantially collapsed or have been effectively reclaimed. It is our opinion that a Severe or Moderate Coal Mine Hazard Area may be developed without restriction (Declassified) provided that the underground mines are shown (by subsurface exploration) to have substantially collapsed.

This may be accomplished by a drilling program (ground proofing). The purpose of ground proofing is to obtain specific subsurface data that can be used to assess the risk of sinkholes and regional ground subsidence and to validate historic coal mine map survey accuracy.

ICE has completed numerous ground proofing programs in abandoned underground coal mine areas in Kittitas and King Counties. The results of these evaluations have demonstrated that typically the mines are found to be substantially collapsed, as would be expected, resulting in a reclassification of the coal mine hazard area. We estimate the cost of such a study will be approximately \$35,000. We can provide a detailed scope of services and fee estimate for this purpose, if requested.

Ken Lyons
Boardwalk Real Estate LLC
July 7, 2015
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10.0 USE OF THIS REPORT

We have prepared this report for Boardwalk Real Estate LLC. The data and report should be provided to prospective contractors for their bidding or estimating purposes, but our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

The parcels subject to this report are located in an area of extensive historical mining. It is possible that undocumented mining (usually a "prospector's tunnel"), an abandoned dry well, septic tank or dug water well, and/or Mine Rock Fill, may be encountered. We recommend that ICE be contacted immediately if a shallow void or evidence of Mine Rock Fill is encountered.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No warranties or other conditions, express or implied, should be understood.

We trust this report meets your present needs. Please call if you have any questions.

Yours very truly,
Icicle Creek Engineers, Inc.




Kathy S. Killman, LEG
Principal Engineering Geologist

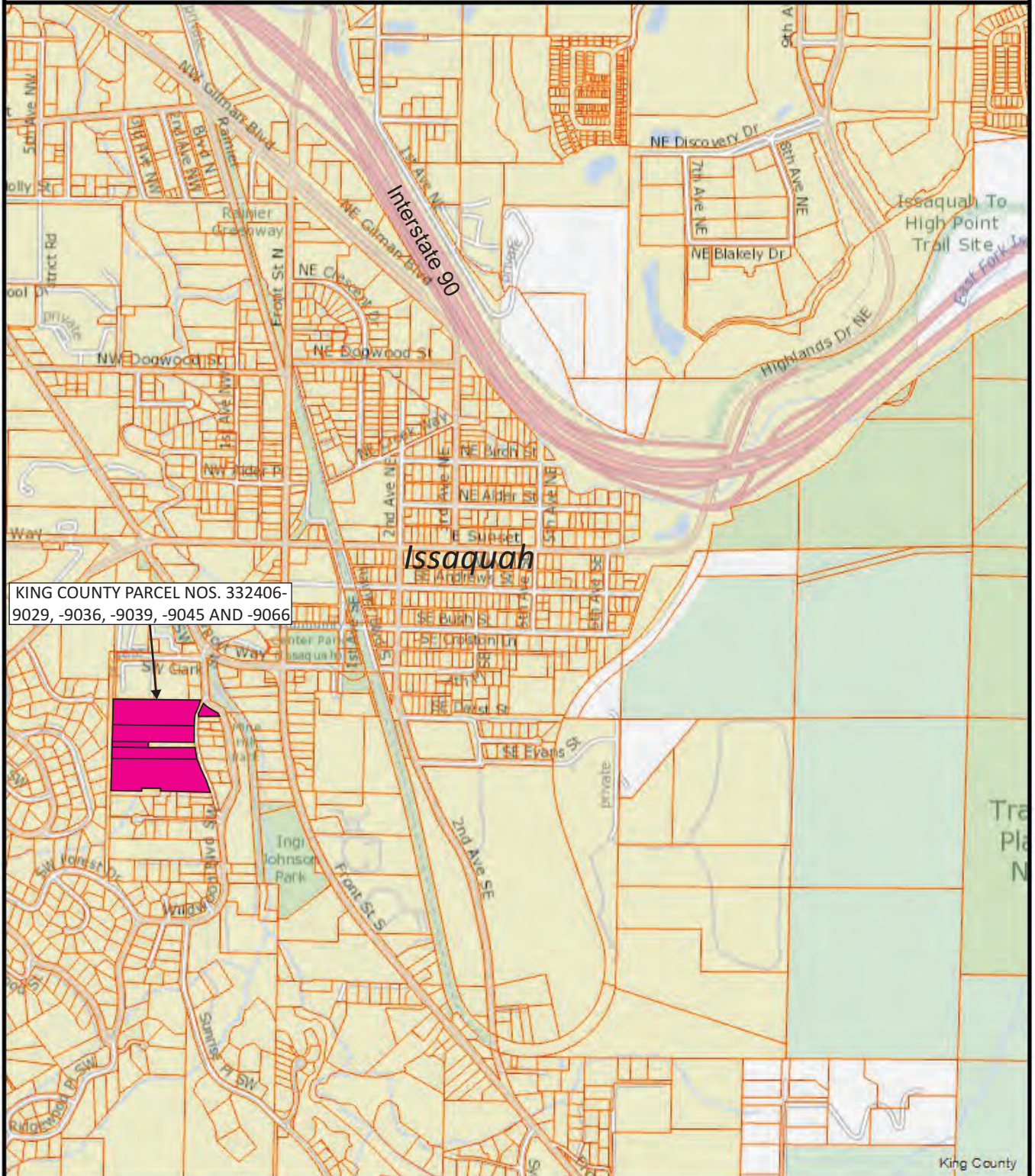

Brian R. Beaman, PE, LEG, LHG
Principal Engineer/Geologist/Hydrogeologist

Document ID: 1131001.REP
Submitted via email (pdf) and surface mail (two original copies)

Attachments: Vicinity Map – Figure 1
Site Plan – Figure 2
Abandoned Underground Coal Mine Map – Figure 3
Geologic Cross-Section A-A' – Figure 4
Geologic Cross-Section B-B' – Figure 5
Coal Mine Hazard Areas Map – Figure 6

FIGURES

King County iMap



KING COUNTY PARCEL NOS. 332406-9029, -9036, -9039, -9045 AND -9066

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Date: 6/17/2015

Notes:



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VICINITY MAP

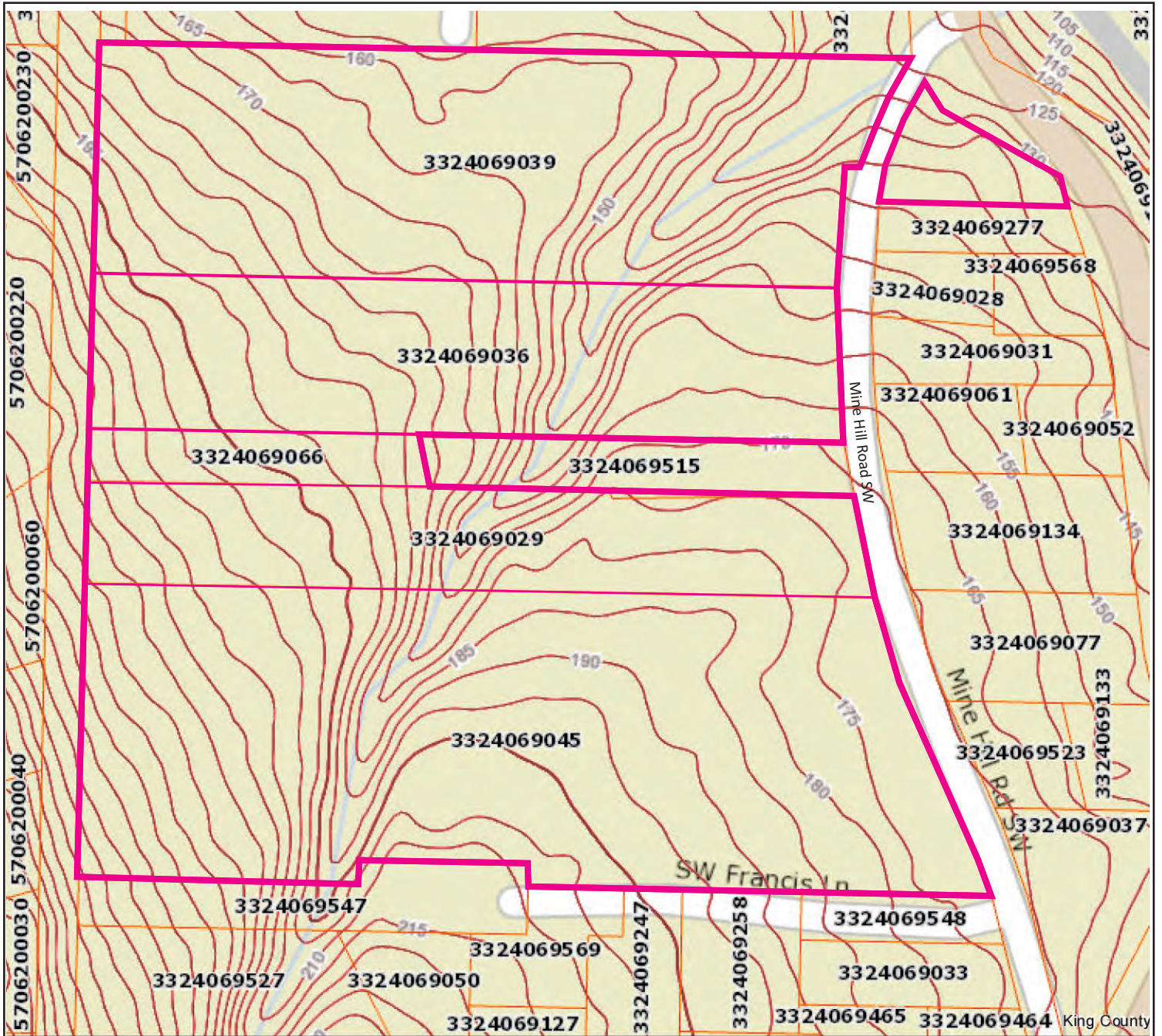
PRELIMINARY COAL MINE HAZARD ASSESSMENT

KING COUNTY PARCEL NOS. 332406-9029, -9036, -9039, -9045 AND -9066, ISSAQUAH, WA

ICICLECREEK
ENGINEERS
29335 NE 20th Street
Carnation, Washington 98014
(425) 333-0093

SCALE: None
DESIGNED: ---
DRAWN: BRB
CHECKED: KSK
DATE: 07/07/15

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1131-001
Figure
1



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0 125 150
Approximate Scale in Feet

EXPLANATION

— Subject Parcel Boundaries

SITE PLAN

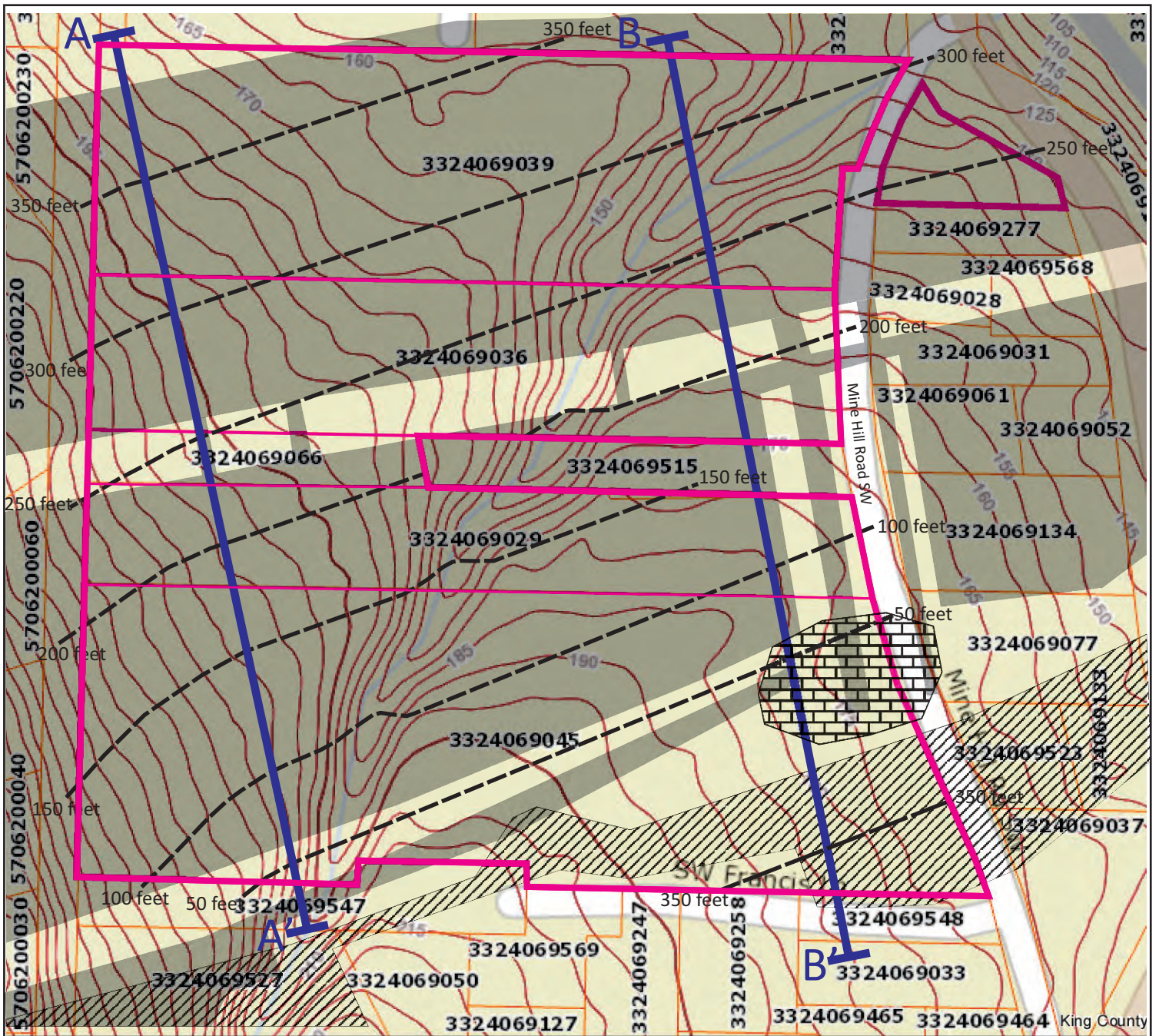


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PRELIMINARY COAL MINE HAZARD ASSESSMENT
KING COUNTY PARCEL NOS. 332406-9029, -9036, -9039, -9045 AND -9066, ISSAQUAH, WA



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0 125 150
Approximate Scale in Feet

EXPLANATION

- Subject Parcel Boundaries
- No. 4 Mine
- No. 1 Mine
- No. 4 Mine Main Entry Area
- - - Depth to Underground Mine Workings (approximate)
- A' — A Location of Geologic Cross-Section (see Figures 4 and 5)

Notes: 1) The location for the No. 4 Mine and No. 1 Mine is based on historical mine maps obtained from the Washington State Department of Natural Resources (<https://fortress.wa.gov/dnr/geology/?Theme=coalmine>), Pacific Coast Coal Co., Map of Issaquah Mines, 1918, Map K7.

2) Location is approximate; no subsurface exploration has been completed to evaluate the actual location and status of the abandoned underground mines.

ABANDONED UNDERGROUND COAL MINE MAP

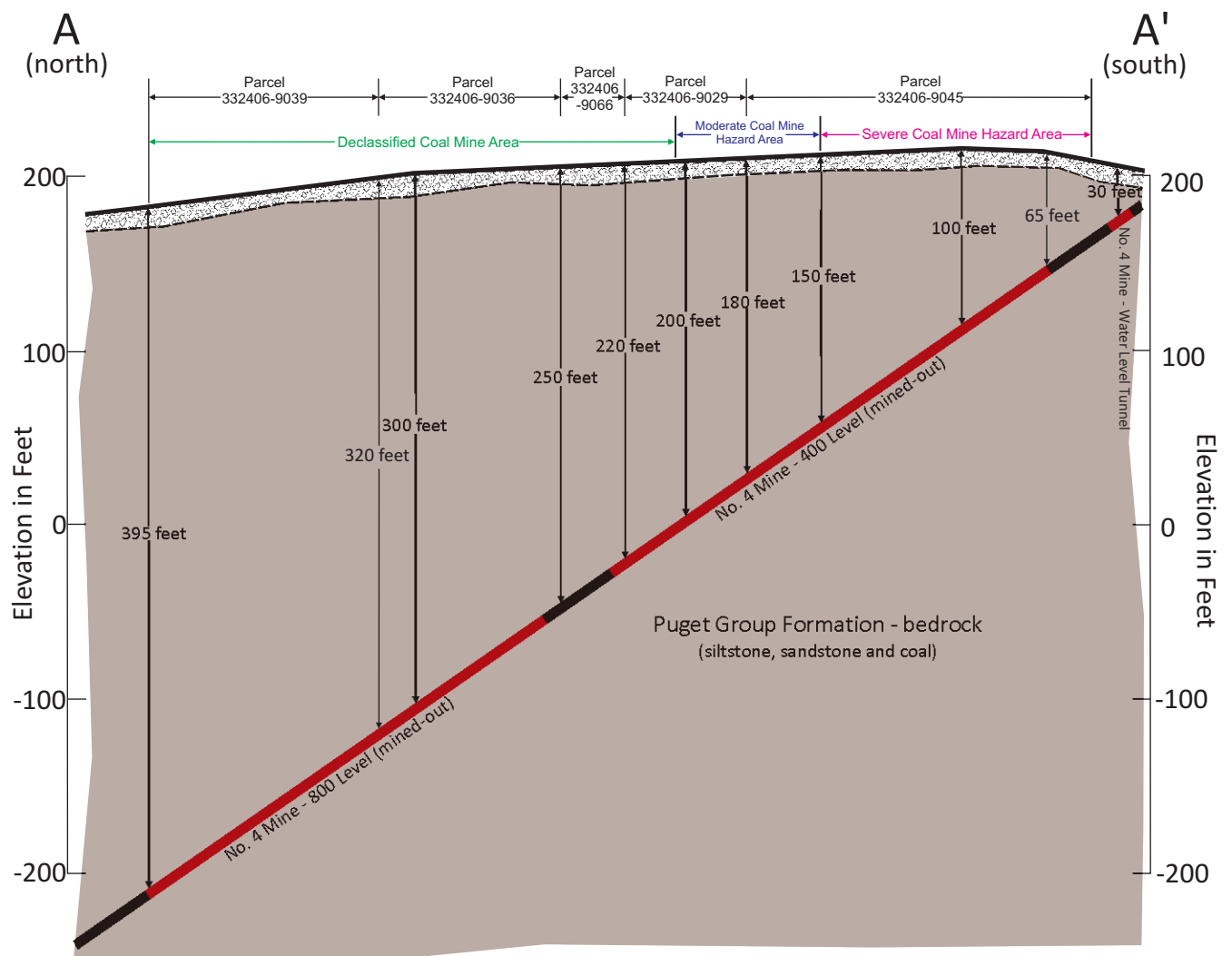
PRELIMINARY COAL MINE HAZARD ASSESSMENT
KING COUNTY PARCEL NOS. 332406-9029, -9036, -9039, -9045 AND -9066, ISSAQUAH, WA

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0 100 200
Approximate Scale in Feet
Horizontal Scale = Vertical Scale

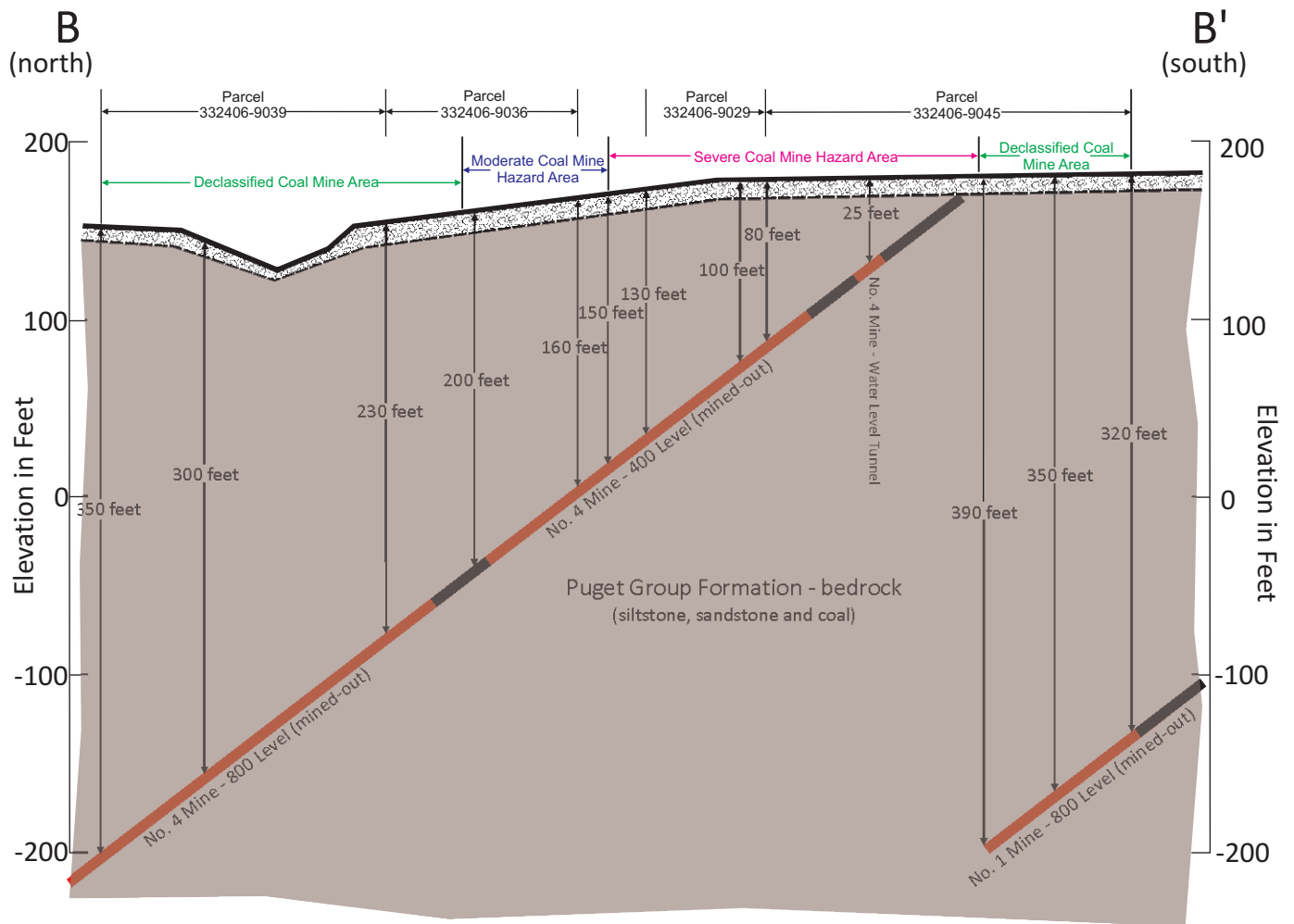
GEOLOGIC CROSS-SECTION A-A'

PRELIMINARY COAL MINE HAZARD ASSESSMENT
KING COUNTY PARCEL NOS. 332406-9029, -9036, -9039, -9045 AND -9066, ISSAQUAH, WA

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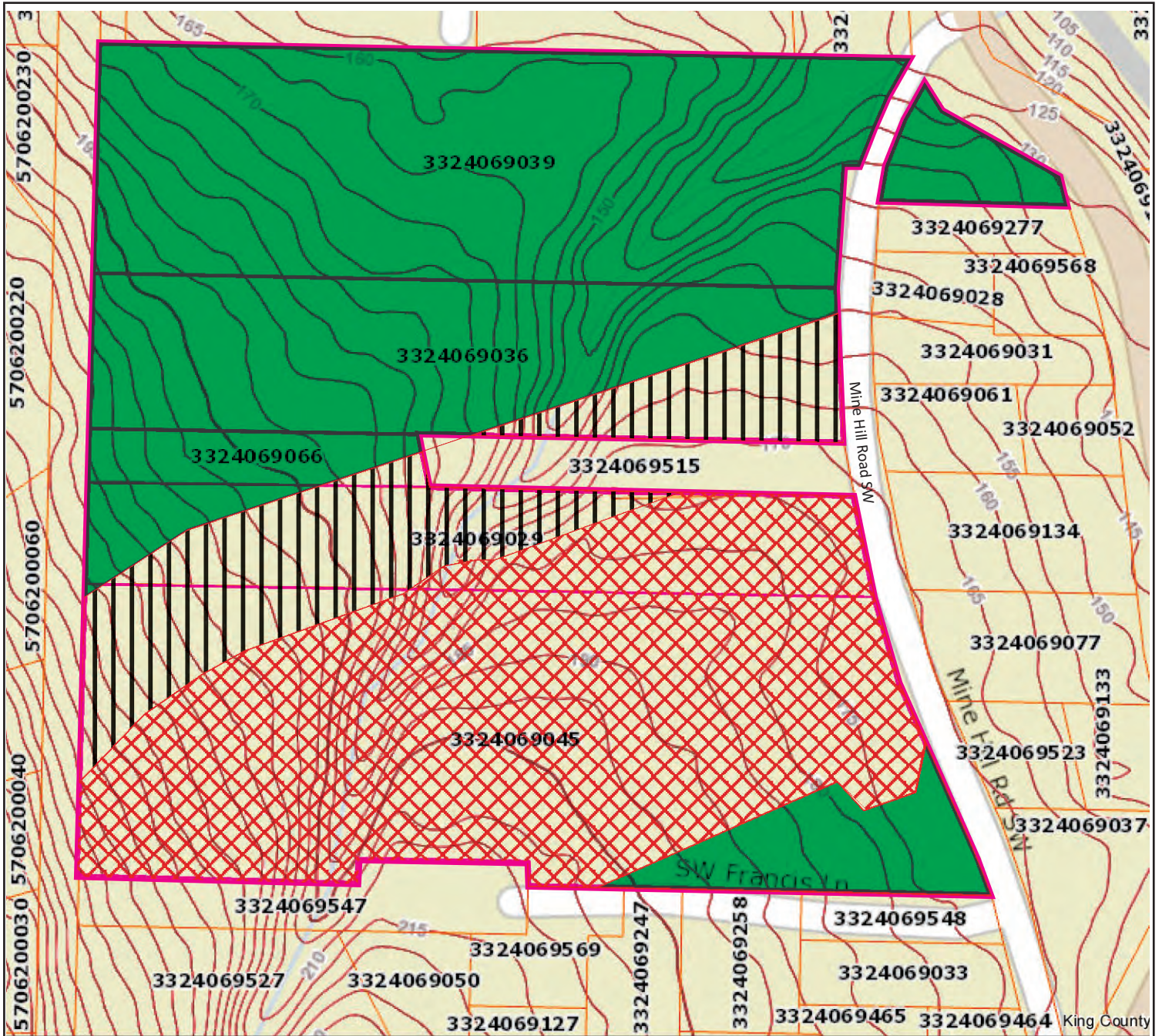
GEOLOGIC CROSS-SECTION B-B'

PRELIMINARY COAL MINE HAZARD ASSESSMENT
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Approximate Scale in Feet

EXPLANATION



Severe Coal Mine Hazard Area



Moderate Coal Mine Hazard Area



Declassified Coal Mine Area



Subject Parcel Boundaries

COAL MINE HAZARD AREAS MAP

PRELIMINARY COAL MINE HAZARD ASSESSMENT
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